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U. S. DEPARTMENT OF AGRICULTURE.

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REPORT RECEIVED
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U. S. Department of Agriculture,
OF THE

CHIEF OF THE DIVISION OF CHEMISTRY

FOR

1896.

BY

H. W. WILEY.

[FROM THE REPORT OF THE SECRETARY OF AGRICULTURE.]



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REPORT OF THE CHIEF OF THE DIVISION OF CHEMISTRY.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., September 10, 1896.

SIR: In accordance with the instructions received from the honorable Secretary of Agriculture, I submit herewith for your consideration the report of the work of the Division of Chemistry for the fiscal year ended June 30, 1896, together with some suggestions in regard to promoting the efficiency of the work of the division and an estimate of the appropriations required for the fiscal year ending June 30, 1898.

Respectfully,

H. W. WILEY,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

ANALYTICAL WORK.

The total number of samples submitted for analysis, on hand July 1, 1895, was 495. These samples consisted of 253 cereals, 51 other human food products, 3 cattle foods, 78 products of pot experiments with soils, 18 fertilizers, 54 soils, 9 ashes, and 27 miscellaneous samples.

Many of these samples were partly analyzed before the commencement of the fiscal year begun July 1, 1895. The greater part of them, however, was still awaiting analytical work. During the past fiscal year there were received at the laboratory 1,230 samples, classified as follows:

Cereals, 35; other human food products, 557; food adulterants, 23; cattle foods, 24; products of pot experiments with soils, 224; waters, 19; fertilizers, 34; soils, 125; samples for the Association of Official Agricultural Chemists, 31; ashes, 25; miscellaneous, 133.

During the year 657 analyses were completed and reported, classified as follows:

Cereals, 14; other human food products, 355; food adulterants, 23; cattle foods, 25; waters, 18; fertilizers, 49; soils, 12; samples for the Association of Official Agricultural Chemists, 31; ashes, 11; miscellaneous, 119.

The number of samples on which work had not been commenced or was not finished at the close of the year was as follows:

Cereals, 274; other human food products, 253; cattle foods, 2; products of pot experiments with soils, 302; water, 1; fertilizers, 3; soils, 167; ashes, 23; miscellaneous, 43; total, 1,068.

In explanation of the above statement, it may be said that the analytical work on many of the samples was nearly completed at the end of the fiscal year and has since been finished. This is especially true of the cereals, other human food products, and products of pot experiments and soils. Shortly after the commencement of the present fiscal year the analysis of the cereals was completed and the results reported to the Division of Vegetable Physiology and Pathology, from which the samples had been received. More than half of the samples of other human food products, products of pot experiments, and soils were finished and reported shortly after the commencement of the present fiscal year. Nevertheless, the fact remains, as is shown by the above figures, after the proper corrections, as indicated, that the force of the division is not large enough to keep up with the work which it has undertaken.

CHANGES IN PERSONNEL.

During the year two of the assistants in the division left the public service to accept employment at more remunerative wages in manufacturing establishments. Only one appointment was made during the year to fill the vacancies thus occasioned.

CHARACTER OF THE WORK.

But little change was made during the year in the character of the work of the division. The chief lines of investigation are still in the direction, on the one hand, of the composition and adulteration of human foods and, on the other, of the composition and characteristics of the typical soils of the United States with especial reference to their biological relations, the micro-organisms which they contain, and to the plants growing therein. The nature of the work undertaken in this direction is unique, consisting of triple investigations having for their object the determination of the chemical and physical characteristics of the soil, the nature and activity of the nitrifying organisms contained therein, and the determination of the relations of the soil to the growing plant as indicated by cultural experiments in pots, which are subjected to identical conditions of control.

MISCELLANEOUS INVESTIGATIONS.

In addition to these principal lines of investigation, the usual miscellaneous work of the division has been carried on. The analysis of mineral waters, patent medicines, and ores of the precious metals has been uniformly declined. It is well, however, to again emphasize the fact, which still seems to be unappreciated, that it is impracticable for this division to undertake complete analyses of mineral waters, proprietary medicines, and minerals containing precious metals. It would be well for the people of the country to understand that there is no department of the Government where such analyses can be secured.

The firm stand which has been recently taken by the Department in refusing to authorize analyses even of agricultural and food products and fertilizers, and to give certificates therefor which can be used for advertising, has already borne good fruit. The demands for such analyses, while they have not ceased, have nevertheless diminished very much in frequency and insistency.

COÖPERATION WITH ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The division continues as heretofore to cooperate with the Association of Official Agricultural Chemists in its highly useful and practical work. This association, composed of men connected with the State boards of agriculture, agricultural colleges, and experiment stations, has for its principal object the formulation of methods of analysis embodying the latest and best processes for the accurate analytical determination of the components of soils, fertilizers, and agricultural products. The methods agreed upon by the association become for the following year the official methods for the whole country. While it is not claimed that these methods are absolutely exact, yet they represent the best theory and practice of the times. The association, while conservative, is ever willing to adapt its methods to recent discoveries and improvements as soon as their merits have been established.

One of the most interesting problems which now confronts the association, and in which the Division of Chemistry is already interested, relates to the possibility of determining the availability of plant foods by strictly chemical methods. It is believed by this division that the only rational method of securing these results is to combine the chemical methods in the laboratory with the actual results obtained by plants under standard conditions of culture. It is this idea which is now elaborating in the pot-culture experiments begun four years ago and still vigorously prosecuted by this division.

The relations of the growing plant to different forms of phosphoric acid presented to it in commercial fertilizers is one of special prominence. It now seems to be well established by experiments with plants that the availability of phosphatic foods can not be arbitrarily measured by their solubility in water and a neutral solution of ammonium citrate of a given specific gravity. The chemical world is gradually reaching the conclusion that each type of phosphatic fertilizing material deports itself in a specific manner with a given plant and soil, and that different types of plants differ in their relations to a given phosphatic food. It follows from this that any method of chemical analysis, which would definitely establish the availability of a given phosphatic fertilizer for a given plant, in a given soil, might lead to wholly erroneous data, if any one or two of the factors above mentioned be varied. The experiments which have been conducted by this division lead to the conclusion that the soil itself is one of the most important of these variables. A large part of the work, therefore, in connection with the Association of Official Agricultural Chemists, has been for some time and is still directed to a study of the availability of plant food as determined by the variations in the form of the food itself, of the plant to which it is fed, and the soil with which it is mixed.

PROGRESS OF THE WORK.

For the fiscal year ended June 30, 1896, I am able to report the following progress in the work of the division:

In the work on the composition of foods and investigation of food adulterations, an extensive study of the presence of zinc in evaporated fruits has been completed and the results published in Bulletin 48. The investigation of this subject was undertaken by reason of complaints,

made through our consular agents in Europe, to the State Department, of the prohibition and restriction of the sale of American evaporated fruits in the continental markets. The ground for the prohibition complained of was the alleged presence of zinc, in quantities deleterious to health, in American evaporated fruits due to the drying of these fruits on trays made of galvanized iron. A representative of the division visited the principal centers for the manufacture of evaporated apples and collected an extensive series of samples. Other samples were obtained from exporters and still others from the consular agents in Europe, representing evaporated fruits which had been condemned and prohibited of sale by the health authorities. The results of the examination showed the constant presence of a small amount of zinc in all fruits dried on galvanized-iron trays. The quantities of zinc found, however, in all cases, were extremely minute, being in no instance sufficient to imperil health. In order, however, to avoid any cause whatever of complaint, the manufacturers of evaporated fruits were advised to substitute other materials for the galvanized iron in the trays of their furnaces. Iron wire coated with tin was recommended, for theoretical reasons. A series of experiments was conducted in this division with trays made of aluminum wire, which conclusively proved that this material could be used as an acceptable substitute for galvanized iron and by its use every possible objection hitherto urged against the sale of American evaporated fruits in European markets would be withdrawn. The great abundance and cheapness of aluminum at the present time render the change from the galvanized iron wire trays to those made of aluminum wire easy of accomplishment at a moderate expense.

The analytical work in the study of the composition of foods and of their adulterants has been pushed as vigorously as the diminished appropriation for this purpose would permit. The work during the year was confined almost exclusively to an examination of foods made from cereal products. An attempt has been made to secure samples of every leading prepared cereal food which is offered for sale in the United States. Restricted, however, as we are by the paucity of funds to the local markets, it would not be surprising to find that many of these foods manufactured and sold in other localities have been omitted from our list. In addition to the local markets, we have made a careful study of the advertisements of prepared foods in the periodical press of different parts of the country, and in this way have been enabled to secure many samples which are not offered for sale in our local markets. It is believed that a fairly representative collection has been made of breakfast foods, breads, cakes, biscuits, and other cereal preparations. By reason of the magnitude of the analytical work and the impracticability of placing the whole of the force on this line of investigation, the progress of the work has been annoyingly slow, but at the end of the year it was practically completed and the results will be published during the present fiscal year as Part 9 of Bulletin No. 13.

The work in the investigation of typical soils was prosecuted during the year with all possible vigor. For the reasons just mentioned the progress in this work has also been much slower than could be desired. Only three of the members of the force could be spared for the analytical work, while a fourth has been occupied almost exclusively with the bacteriological examinations. Two crops were harvested from the culture pots during the year, one of beans and oats in July and another of buckwheat in September. By varying the

crops in this way it is possible to secure two harvests during a season. In the early spring of the present year the pots were again planted to pease and beans, but the harvest of this crop was not accomplished until the beginning of the present fiscal year. In work of this kind it is unsafe to draw any conclusions until a large amount of analytical data, extending over several seasons, has been accumulated. The results obtained, however, are of such a nature as to strengthen the belief that the method now trying is the most rational one which has heretofore been devised for a complete study of soils in relation to their possibilities of producing crops.

The work of the division in collaboration with the Association of Official Agricultural Chemists has been successfully prosecuted on every point submitted for investigation by that body. It is believed that a special function of the Division of Chemistry is found in determining the value of proposed innovations in method of analysis of soils, fertilizers, and agricultural products, and no better opportunity for the prosecution of this kind of work could possibly be presented than is found in connection with the work of the Association of Official Agricultural Chemists.

In addition to this work, some of the assistants in the division have also undertaken the task of abstracting methods of analysis relating to agricultural interests for publication in the Experimental Record of the Office of Experiment Stations.

In the miscellaneous work of the division commendable progress may be reported, although it is the policy of the division to subordinate the miscellaneous work to that of research, along the main lines of investigation, whenever possible.

PUBLICATIONS.

The following publications were prepared by the Division of Chemistry during the fiscal year ended June 30, 1896:

Bulletin No. 46. Methods of Analysis adopted by the Association of Official Agricultural Chemists.

Bulletin No. 47. Proceedings of the Twelfth Annual Convention of the Association of Official Agricultural Chemists.

Bulletin No. 48. Zinc in Evaporated Apples.

RECOMMENDATIONS.

In the interests of the public service and the efficiency of the division the following recommendations are made:

1. That necessary additions in the chemical force of the division be made as soon as possible from the eligible list as determined by the United States Civil Service Commission. The above recommendation has already been acted upon, as I am credibly informed, by your request, that the Civil Service Commission will hold an examination for this purpose. It is feared, however, that by reason of the diminution of our appropriation for chemical work for the current fiscal year, amounting in all to \$2,500, it will not be practicable at the present time to secure the employment of more than one additional assistant.

2. I earnestly recommend your favorable consideration of the proposition for increasing the pay of the chemical assistants of the division. It is the avowed policy of the Department to pay higher wages for expert service. I need only call your attention to the fact that there are now employed in this division chemical experts who have devoted

many years of their lives to professional studies in preparing themselves for their work and who are at the present time receiving less compensation than many persons employed in clerical work in the Department.

3. I desire again to call your attention to the fact that this division stands ready at all times to cooperate with other divisions in scientific work. During the past fiscal year many opportunities for this cooperation have been presented to us and all have been cheerfully improved. Only when the amount of work which is required is such as to seriously impair the lines of work specially undertaken by the division, is it probable that cooperation could not be accorded. In such cases the Division of Chemistry would be glad to undertake chemical work for other divisions, provided the funds of such divisions be employed for the temporary employment of experts for the purpose. The establishment of separate chemical laboratories for other divisions of the Department would tend to disintegrate the chemical work of the Department and render it more expensive and less efficient.

4. The quarters now occupied by the Division of Chemistry are entirely inadequate for the accommodation of a laboratory representing the Department of Agriculture. The rooms are small, poorly ventilated, and crowded to inconvenience. There is not a single room in the house of which the temperature can be controlled, thus making impossible a condition important in many chemical operations. About a year ago a request was made of this division for an estimate for floor space for a laboratory in the new post-office building. I would urge upon you the necessity of securing space in this building, if possible, where the chemical laboratory of the Department could be installed in a manner suitable to the magnitude of its interests and the character of its work.